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Saitou et al.

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(54) **MAGNETRON AND DEVICE USING MICROWAVES**

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H01J 25/50 (2006.01)

(52) **U.S. Cl.**
USPC **315/39.51**; 315/39.69; 315/39.75

(58) **Field of Classification Search**
CPC H01J 23/22
USPC 315/39.51, 39.69, 39.75
IPC H01J 25/587, 23/22
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,743,805 A * 5/1988 Takada 315/39.75
5,635,797 A * 6/1997 Kitakaze et al. 315/39.51

(Continued)

FOREIGN PATENT DOCUMENTS

JP	51-113360 U	9/1976
JP	53-003770 A	1/1978
JP	56-156647 A	12/1981
JP	02-018251 U	2/1990

OTHER PUBLICATIONS

International Search Report for International Application No. PCT/JP2009/006273, dated Dec. 15, 2009, 1 page.

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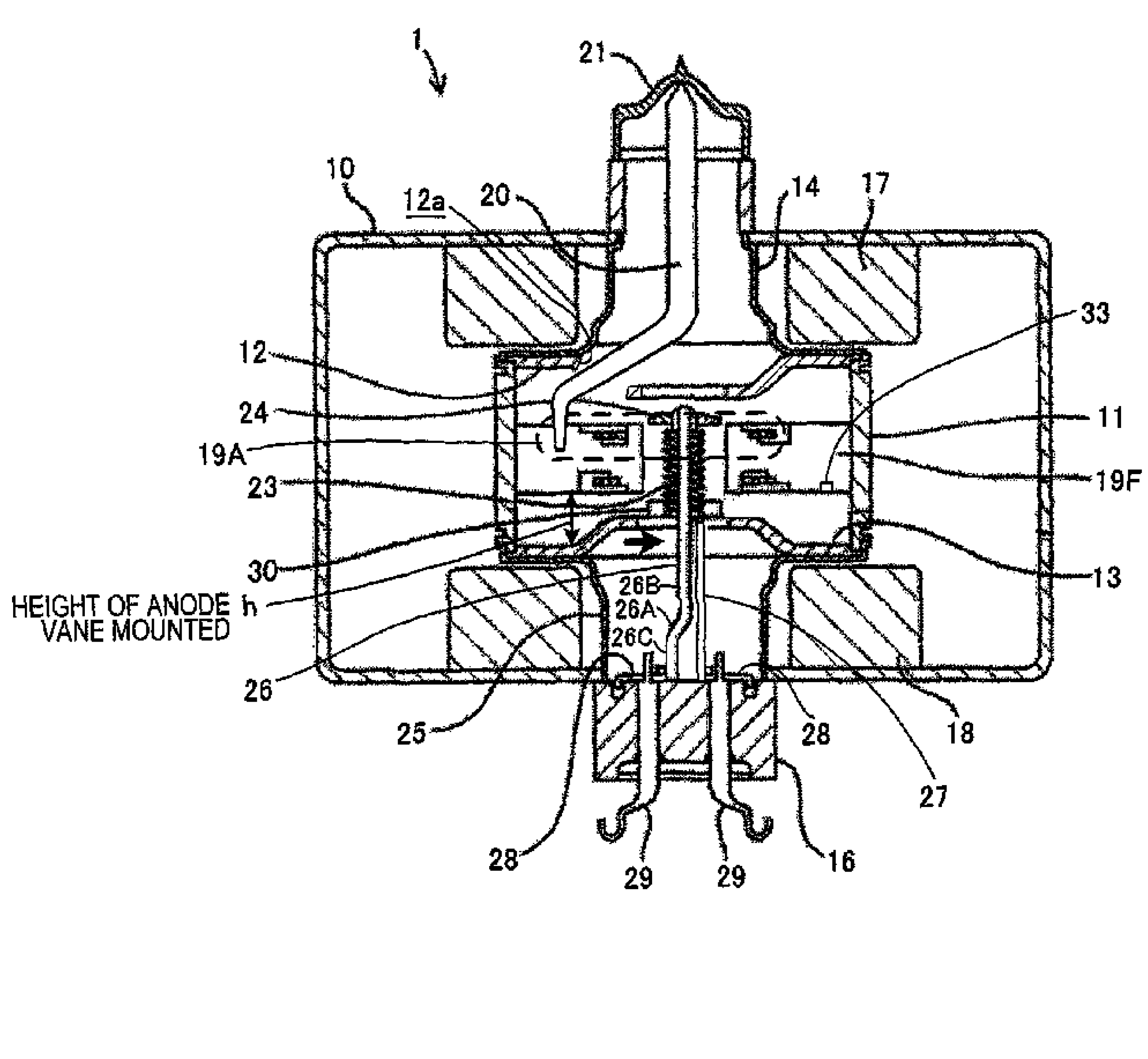
(57) **ABSTRACT**

A magnetron includes: an anode cylinder including anode vanes provided at a predetermined interval on an inner peripheral surface thereof; a center lead including a first linear portion, a second linear portion disposed parallel to the first linear portion and disposed out of alignment with the first linear portion in a plane perpendicular to an axial direction of the anode cylinder, and a bent portion which connects the first linear portion to the second linear portion; and a cathode filament supported by the center lead within the anode cylinder and placed coaxially with the anode cylinder. The center lead is formed so as to become bent between the first linear portion and the second linear portion by the bent portion. A position of one anode vane closest to the bent portion is higher than a position of another anode vane with respect to the axial direction.

11 Claims, 8 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,635,798	A *	6/1997	Ogura et al.	315/39.71
6,653,788	B2 *	11/2003	Ogura et al.	315/39.51
6,670,761	B1 *	12/2003	Lee et al.	315/39.69
6,756,735	B2 *	6/2004	Lee et al.	315/39.51
7,026,762	B2 *	4/2006	Shon et al.	315/39.51
7,122,773	B2 *	10/2006	Yang	219/761
7,220,949	B2 *	5/2007	Lee et al.	219/761
7,375,470	B2 *	5/2008	Baek et al.	315/39.51
7,906,912	B2 *	3/2011	Ishii et al.	315/39.51
2009/0066252	A1 *	3/2009	Higashi	315/39.51
2011/0234093	A1 *	9/2011	Higashi	315/39.51

* cited by examiner

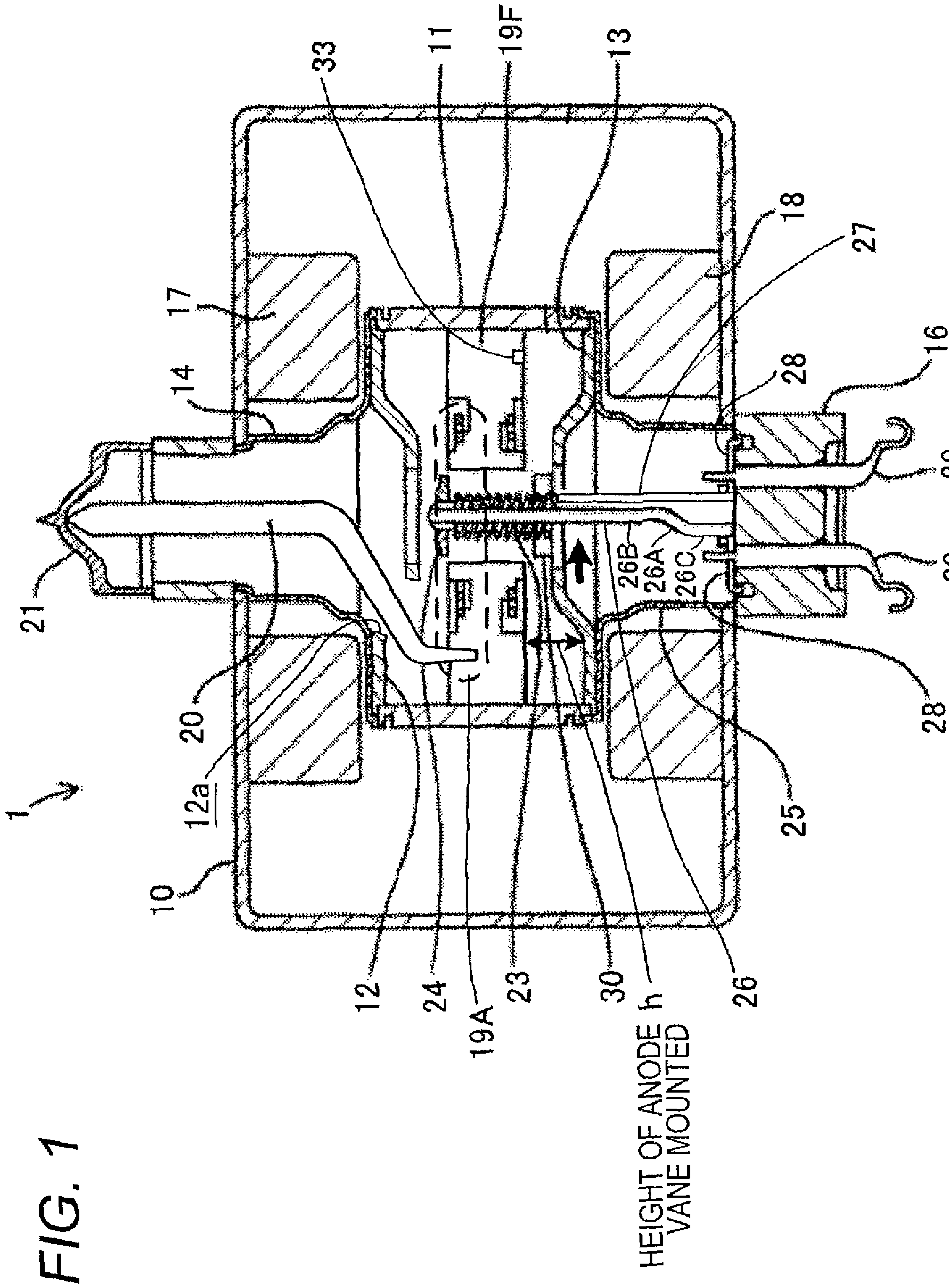

1
10
12a
12
24
19A
23
30
h
26
25
28
20
21
14
17
33
11
19F
13
18
27
16
28
29
29
26B
26A
26C
HEIGHT OF ANODE VANE MOUNTED

FIG. 1

FIG. 2

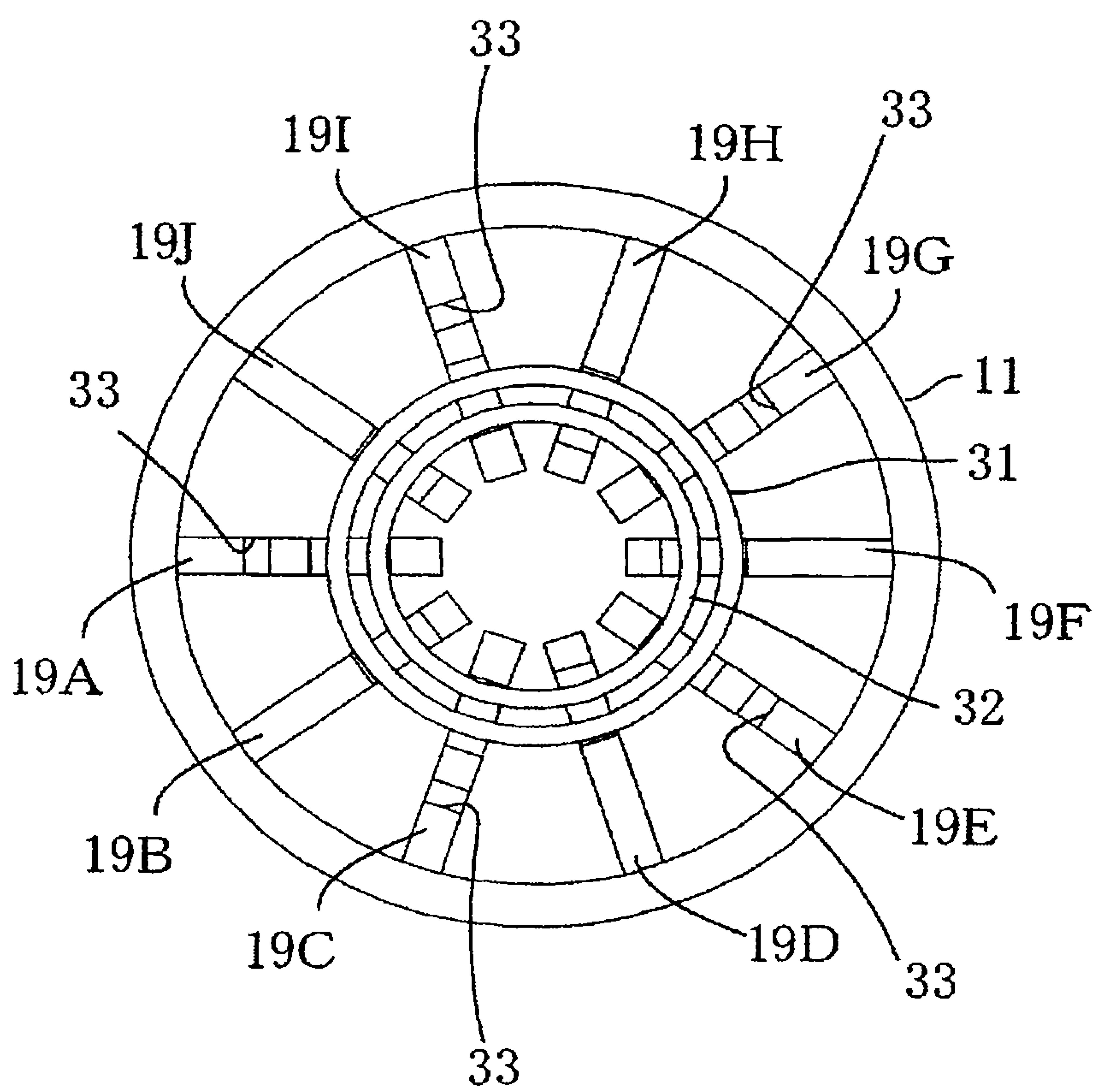


FIG. 3(a)

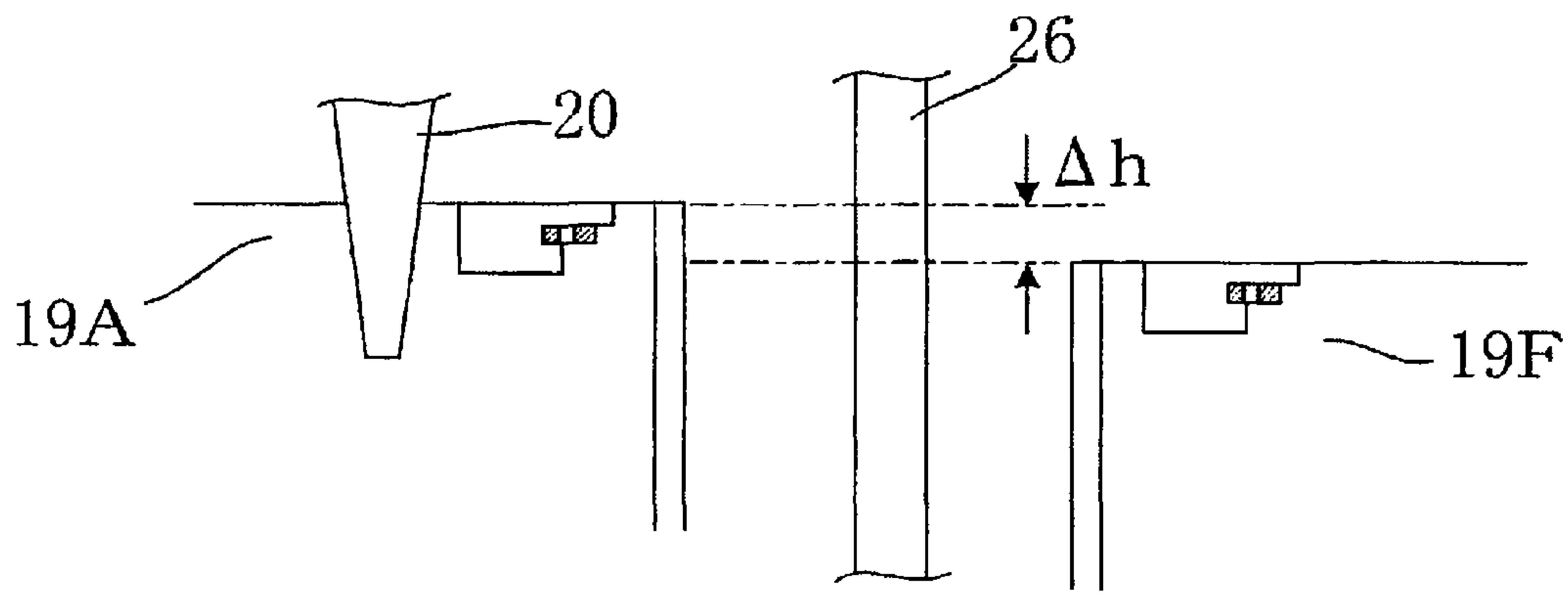


FIG. 3(b)

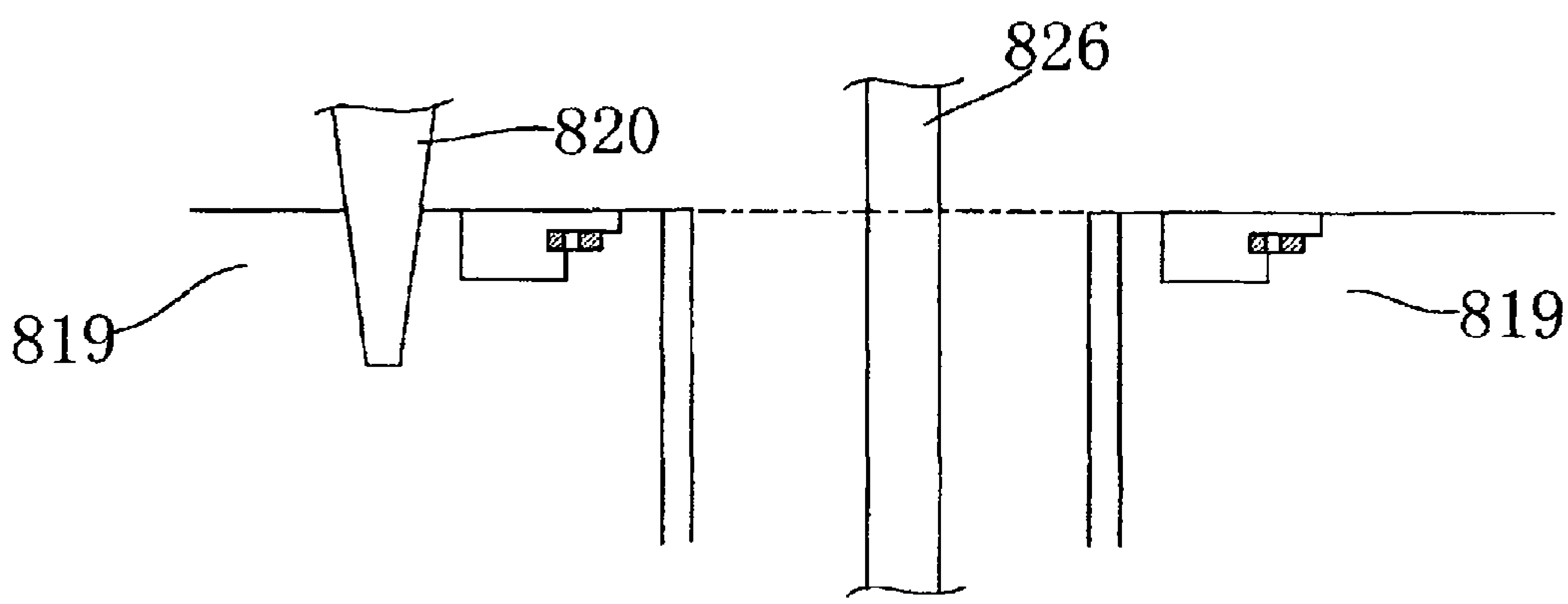


FIG. 4

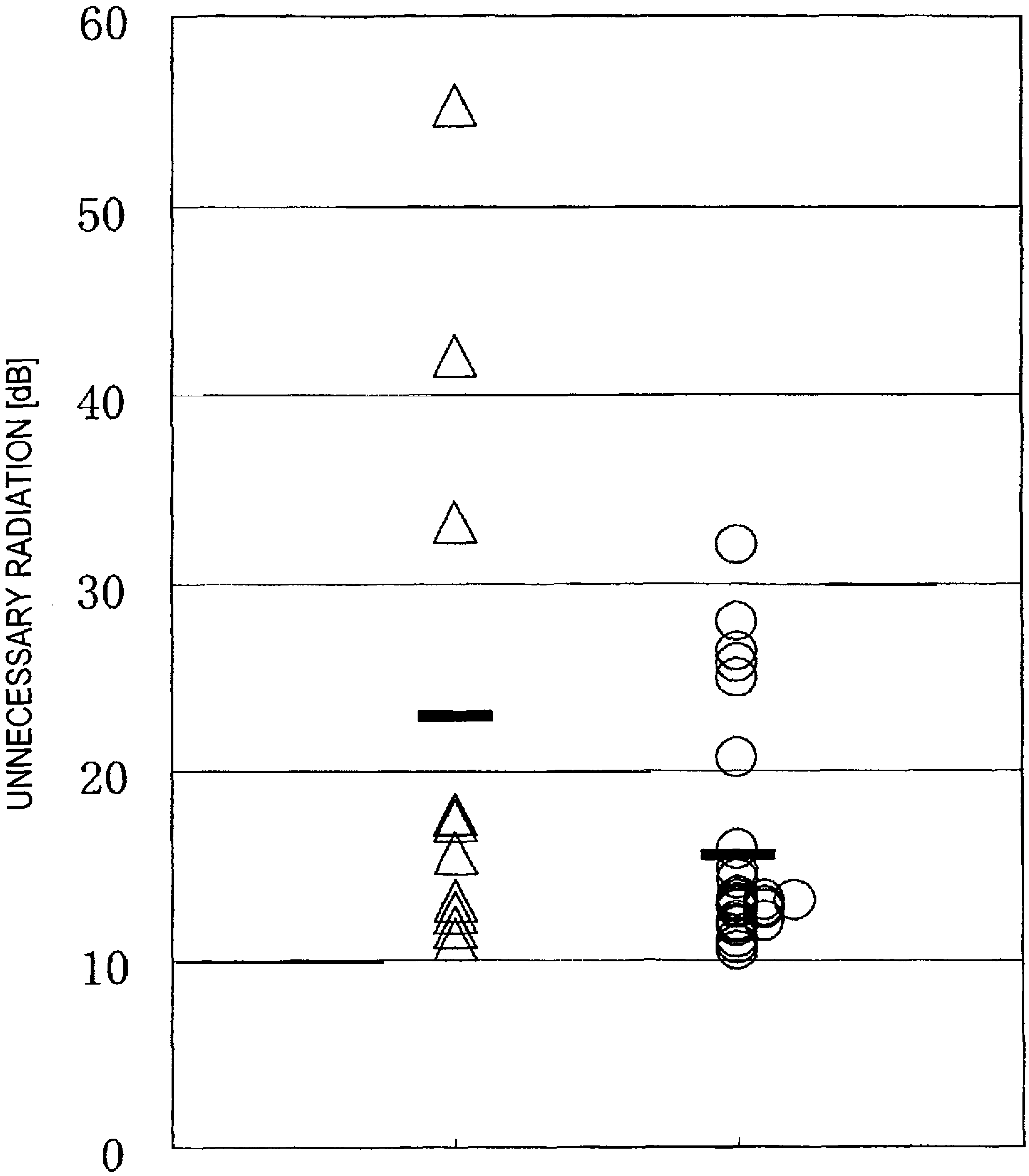


FIG. 5

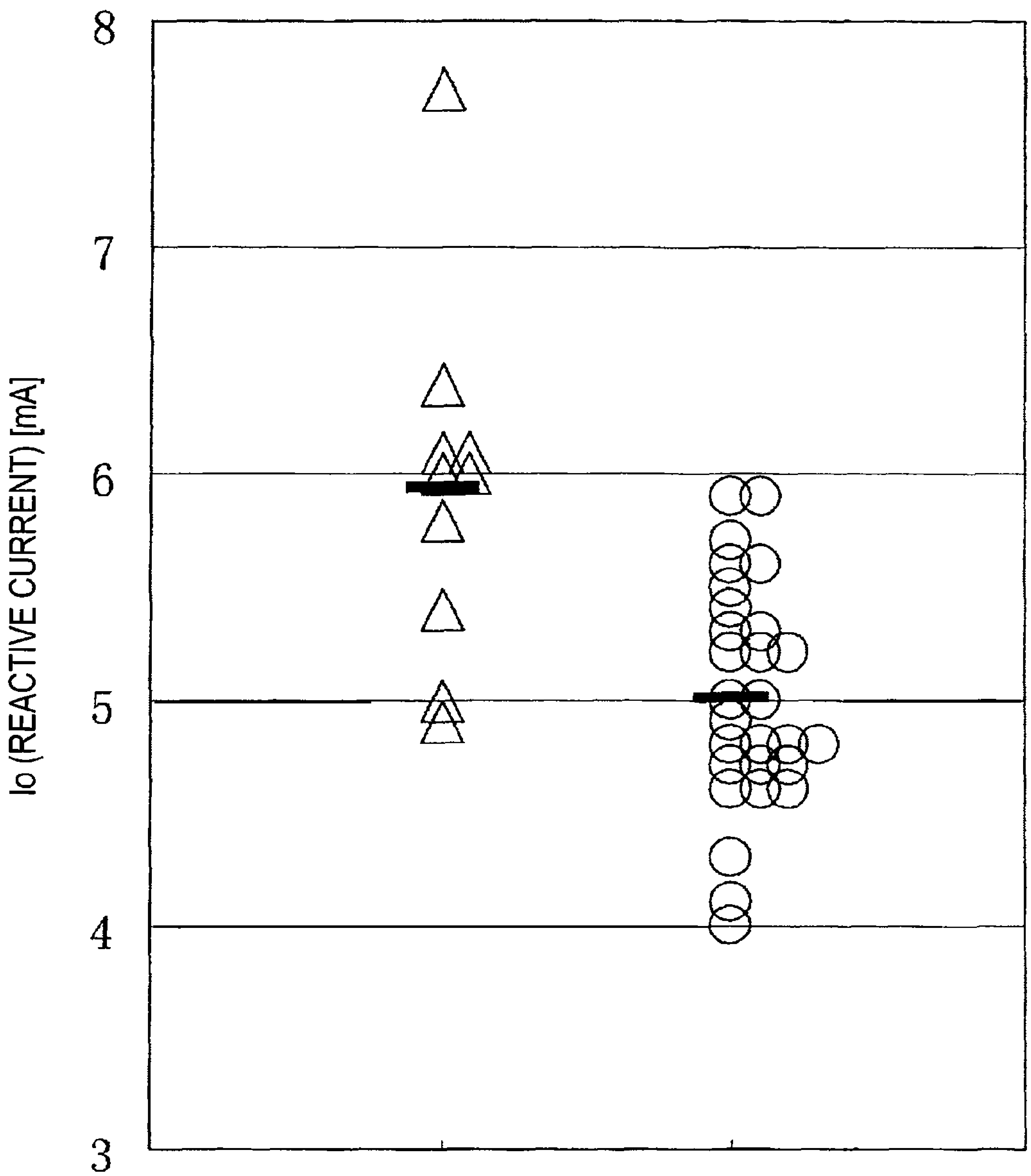


FIG. 6

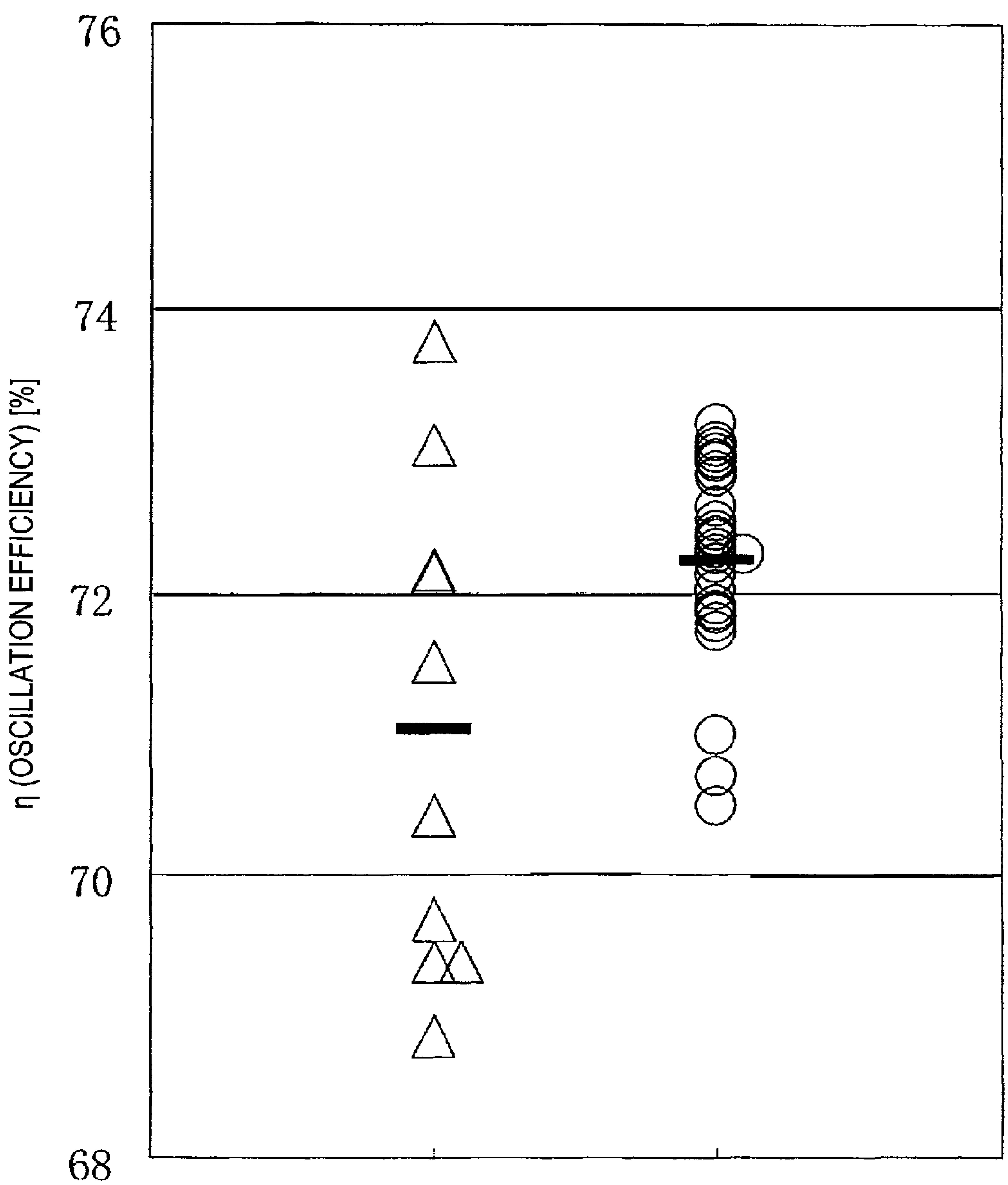


FIG. 7

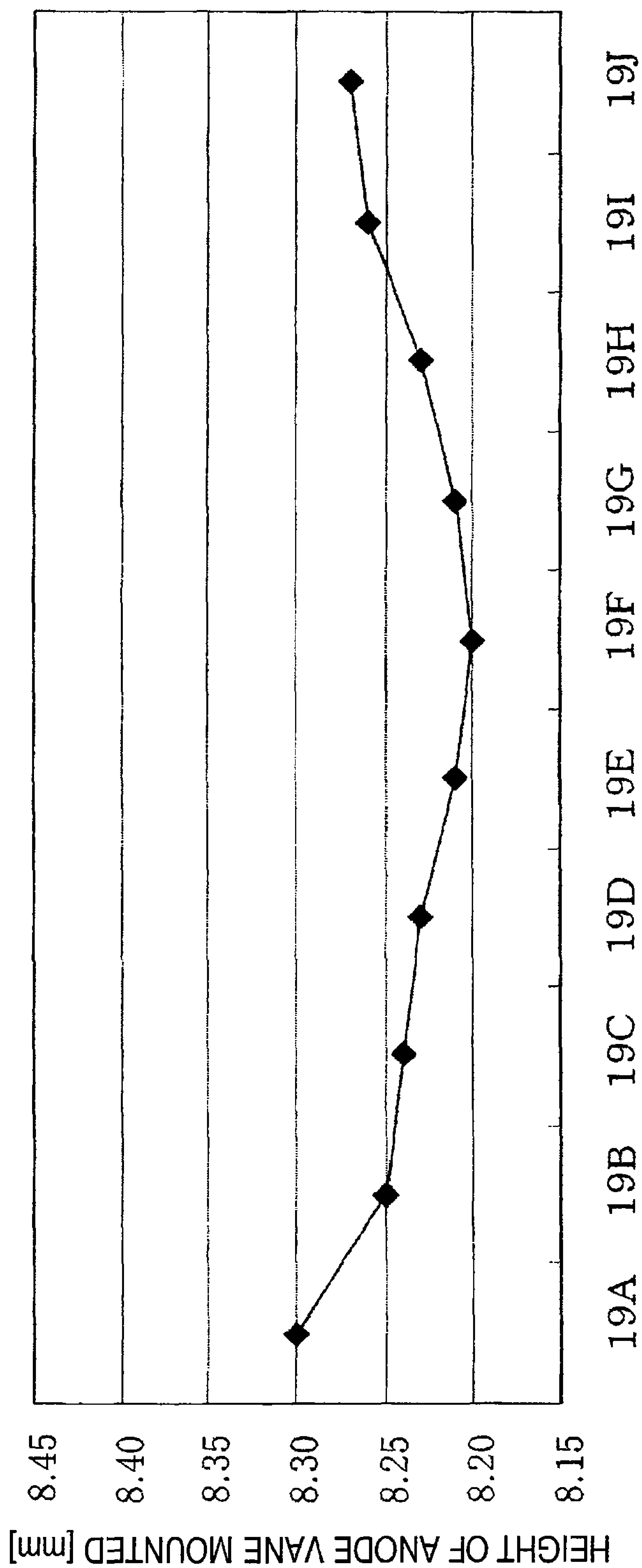
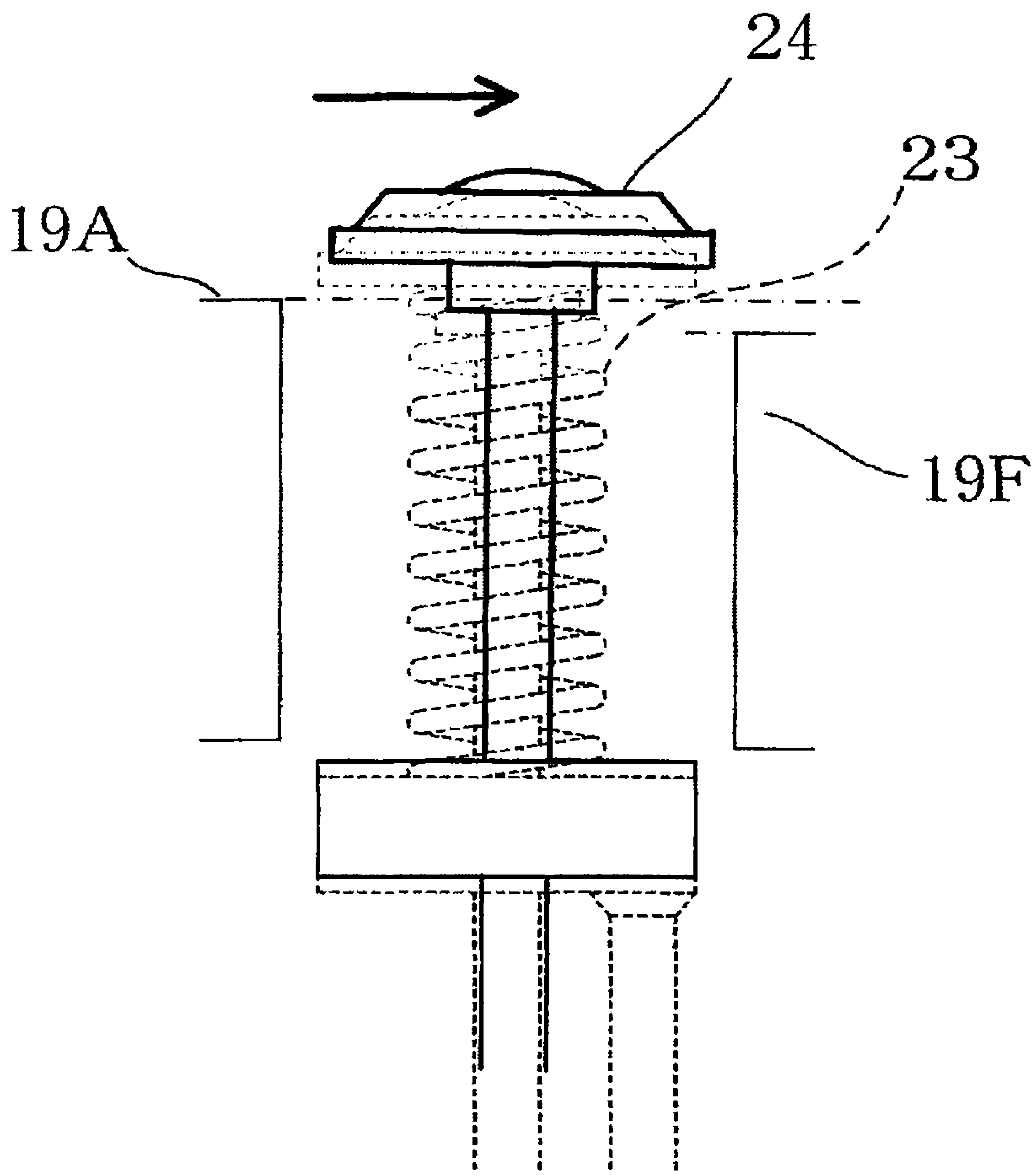

HEIGHT OF ANODE VANE MOUNTED [mm]
8.45
8.40
8.35
8.30
8.25
8.20
8.15
19A
19B
19C
19D
19E
19F
19G
19H
19I
19J

FIG. 8



MAGNETRON AND DEVICE USING MICROWAVES

This application is a 371 application of PCT/JP2009/006273 having an international filing date of Nov. 20, 2009, which claims priority to JP2008-302771 filed on Nov. 27, 2008, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to a magnetron and a device using microwaves, and more particularly to a magnetron built in a device using microwaves such as a microwave oven.

BACKGROUND ART

Various methods have been proposed to mount magnetron anode vanes to an anode cylinder with superior accuracy.

Patent Document 1 discloses a technique of mounting a plurality of anode vanes to an anode cylinder with high accuracy by use of a jig fitting to the anode cylinder and storing the plurality of anode vanes in a radial manner and another jig in which a pin is press-fitted into a center space defined by the plurality of anode vanes.

Patent Document 2 discloses a technique of forming areas for locking a plurality of anode vanes to an inner peripheral surface of an anode cylinder, thereby enhancing accuracy of mounting positions of the anode vanes.

RELATED ART DOCUMENTS

Patent Documents

Patent Document 1: JP-A-53-3770
Patent Document 2: JP-A-56-156647

SUMMARY OF THE INVENTION

Problem to be Solved by the Invention

However, the techniques described in Patent Documents 1 and 2 merely enhance accuracy in mounting the anode vanes. In other words, the techniques do not determine the mounting positions of the anode vanes in consideration of a case where a magnetron is actually operated.

When a magnetron is actually operated, a member housed in the anode cylinder, for example, a center lead, is considered to become slightly deformed by thermal expansion with heat developing from a cathode filament. Consequently, an inner diameter of the anode vanes is considered to go out of alignment with a center axis of the cathode filament, which may in turn destroy the balance of working space among the anode vanes, so that a reactive current and noise is more likely to occur.

An object of the present invention is to provide a magnetron capable of suppressing generation of a reactive current and noise thereby improving oscillation efficiency during operation of the magnetron, and a device using microwaves which utilizes the magnetron.

Means for Solving the Problem

The present invention provides a magnetron comprising: an anode cylinder comprising a plurality of anode vanes disposed at a predetermined interval on an inner peripheral surface thereof; a center lead comprising a first linear portion, a

second linear portion which is disposed parallel to the first linear portion and which is disposed out of alignment with the first linear portion in a plane perpendicular to an axial direction of the anode cylinder, and a bent portion which connects the first linear portion to the second linear portion; and a cathode filament which is supported by the center lead within the anode cylinder and which is placed coaxially with the anode cylinder, wherein the center lead is formed so as to become bent between the first linear portion and the second linear portion by the bent portion, and wherein a position of one anode vane closest to the bent portion is higher than a position of another anode vane with respect to the axial direction of the anode cylinder.

In the magnetron, positions of the plurality of anode vanes become lower stepwise in the axial direction of the cylindrical anode from the one anode vane to the another anode vane.

When the magnetron operates, a component of a direction in which the cathode filament becomes inclined because of thermal expansion of the bent portion of the center lead on a direction perpendicular to the axial direction of the anode cylinder is identical with a component of a curved direction of the center lead on the direction perpendicular to the axial direction.

In the magnetron, an antenna lead is connected to the one anode vane.

A device using microwaves of the present invention comprises the magnetron.

Advantages of the Invention

The magnetron of the present invention and the device using microwaves which uses the magnetron can suppress generation of a reactive current and noise thereby improving oscillation efficiency during operation of the magnetron.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing an entire configuration of a magnetron **1** of an embodiment.

FIG. **2** is a plan view of a plurality of anode vanes **19**A to **19**J when an inside of an anode cylinder **11** is viewed from above.

FIG. **3**(*a*) is an enlarged partial cross-sectional view of the anode vanes **19**A and **19**F surrounded by a chain line shown in FIG. **1**, and FIG. **3**(*b*) is an enlarged cross-sectional view of an area of a related art example magnetron which is the same as that shown in FIG. **3**(*a*).

FIG. **4** is a diagram showing results of measurement of unnecessary radiation levels [dB] from samples of the magnetron **1** of the present embodiment and comparative example samples.

FIG. **5** is a diagram showing results of measurement of reactive currents [mA] in the samples of the magnetron **1** of the embodiment and the comparative sample examples.

FIG. **6** is a diagram showing results of measurement of oscillation efficiency [%] of the samples of the magnetron **1** of the embodiment and the comparative sample examples.

FIG. **7** is a diagram showing results of measurement of mounting heights of respective anode vanes **19**A to **19**J, in connection with the sample of the magnetron **1** of the embodiment that has exhibited a measurement result of highest oscillation efficiency.

FIG. **8** is a diagram showing appearance of a cathode filament **23** before and during operation of the magnetron **1** of the embodiment.

MODE FOR CARRYING OUT THE INVENTION

An embodiment of the present invention is hereunder described by reference to the drawings.

FIG. **1** is a diagram showing an entire configuration of a magnetron **1** of the present embodiment.

In FIG. **1**, the magnetron **1** of the embodiment includes a magnetic yoke **10**; a anode cylinder **11**; an output pole piece **12** coupled to an upper-end opening of the anode cylinder **11**; an input pole piece **13** coupled to a lower-end opening of the anode cylinder **11**; an output side tube **14** that covers the output pole piece **12** and that is hermetically coupled to the upper-end opening of the anode cylinder **11**; an input side tube **25** that covers the input pole piece **13** and that is hermetically coupled to the lower-end opening of the anode cylinder **11**; a ceramic stem **16** hermetically coupled to an opening end of the input side tube **25**; a doughnut-shaped annular magnet **17** that is placed on an upper surface of the magnetic yoke **10** and within the same so as to be inserted into the output side tube **14** at a position immediately above the anode cylinder **11**; and a doughnut-shaped annular magnet **18** that is placed on a lower surface of the magnetic yoke **10** and within the same so as to be inserted into the input side tube **25** at a position immediately below the anode cylinder **11**. An exhaust pipe **21** is connected to the upper surface of the magnetic yoke **10**.

A helical cathode filament **23** extends from an upper end shield **24** to a lower end shield **30** along a center axis of the anode cylinder **11**. One end of the cathode filament **23** is fastened to the upper end shield **24**, and the other end of the cathode filament **23** is fastened to the lower end shield **30**. The cathode filament **23** emits thermo electrons upon application of a voltage from a center lead **26** and a side lead **27**, which will be described later.

The center lead **26** made of molybdenum includes: a first linear portion **26**B; a second linear portion **26**C that is parallel to the first linear portion and that is placed out of alignment with the first linear portion within a plane perpendicular to an axial direction of the anode cylinder; and a bent portion **26**A that connects the first linear portion to the second linear portion. In the center lead **26**, one end of the first linear portion **26**B is connected to the upper end shield **24**, and one end of the second linear portion **26**C is connected to an exterior tube steel lead **29** by way of a lead relay plate (grommet) **28** placed in a plane orthogonal to a tube axis of the stem **16**.

The side lead **27** made of molybdenum connects the lower end shield **30** to the exterior tube steel lead **29** by way of the lead relay plate **28** in parallel with the center axis of the anode cylinder **11**. In order to emit thermo electrons from the cathode filament **23**, the center lead **26** and the side lead **27** apply a voltage to the cathode filament **23**.

One end of an output antenna lead **20** is connected to one anode vane **19**A among the plurality of anode vanes **19**A to **19**J. The output antenna lead **20** extends from the anode vane **19**A toward the output pole piece **12** coupled to the upper-end opening of the anode cylinder **11** and further extends upward along the center axis of the anode cylinder **11** by way of a hole **12***a* formed in a portion of a slope of the output pole piece **12**. The other end of the output antenna lead **20** is connected to the exhaust pipe **21** situated above the output side tube **14**.

A configuration of the plurality of anode vanes **19**A to **19**J is described by reference to FIGS. **1** and **2**. FIG. **2** is a plan view of the plurality of anode vanes **19**A to **19**J when the inside of the anode cylinder **11** is viewed from above. As shown in FIG. **2**, the plurality of anode vanes **19**A to **19**J are made up of the ten anode vanes **19**A to **19**J. The ten anode vanes **19**A to **19**J assume the same shape. Each of the anode vanes **19**A to **19**J extends from an inner peripheral surface of the anode cylinder **11** to the center axis of the anode cylinder **11**. The respective anode vanes **19**A to **19**J are arranged at a predetermined interval along the inner peripheral surface of the anode cylinder **11**. Adjacent anode vanes are arranged in opposite vertical directions.

By reference to FIG. **1**, the anode vane **19**A among the plurality of anode vanes **19**A to **19**J comes closest to the bent portion **26**A of the center lead **26**. As mentioned above, one end of the output antenna lead **20** is connected to the anode vane **19**A. The anode vane **19**F is situated, with respect to the anode vane **19**A, at an imaginary extension of a direction of a component (as designated by an arrow in FIG. **1**) of a curved direction of the bent portion **26**A of the center lead **26** on a direction perpendicular to the axial direction. As shown in FIG. **2**, the anode vane **19**F is situated opposite the anode vane **19**A on the inner peripheral surface of the anode cylinder **11**.

As shown in FIG. **2**, equalizing rings **31** and **32** positioned coaxially with the center axis of the anode cylinder **11** are connected to grooves formed in both upper and lower surfaces of the respective anode vanes **19**A to **19**J. Aside from the grooves to which the equalizing rings **31** and **32** are connected, an antenna pullout groove **33** used for mounting the output antenna lead **20** is formed in the ten anode vanes **19**A to **19**J.

Positions where the respective anode vanes **19**A to **19**J are to be mounted are now described by reference to FIGS. **3**(*a*) and **3**(*b*). FIG. **3**(*a*) is an enlarged partial cross-sectional view of the anode vanes **19**A and **19**F surrounded by a chain line shown in FIG. **1**, and FIG. **3**(*b*) is an enlarged cross-sectional view of an area of a related art example magnetron which is the same as that shown in FIG. **3**(*a*). As shown in FIG. **3**(*b*), all anode vanes **819** have hitherto been mounted at the same height on an inner peripheral surface of an anode cylinder. However, as shown in FIG. **3**(*a*), in the magnetron **1** of the present embodiment, the anode vane **19**F located opposite the anode vane **19**A is mounted on the inner peripheral surface of the anode cylinder **11** and at a position that is lower, by an amount of Δh, than the anode vane **19**A closest to the bent portion **26**A of the center lead **26** among the plurality of anode vanes **19**A to **19**J.

The magnetron **1** of the present embodiment and a comparative example magnetron are compared with each other in connection with an unnecessary radiation level [dB], a reactive current [mA], and oscillation efficiency [%] all of which are achieved when the magnetrons are activated. Samples of the magnetron **1** of the present embodiment used in the respective measurements satisfy at least a relationship between the mounting position of the anode vane **19**A and the mounting position of the anode vane **19**F shown in FIG. **3**(*a*). Further, as shown in FIG. **3**(*b*), the comparative example used for measurements is identical in configuration with the magnetron of the present embodiment except all of the plurality of anode vanes **819** are mounted at the same height.

FIG. **4** shows results of measurement of unnecessary radiation levels [dB] from samples of the magnetron **1** of the present embodiment and comparative example samples. In FIG. **4**, (outlined) circular symbols depict results of measurement of the samples of the magnetron **1** of the embodiment, and a horizontal bar depicts an average of the measurement results. Further, (outlined) triangular symbols in FIG. **4** depict results of measurement of unnecessary radiation from the comparative sample examples, and an (outlined) horizontal bar depicts an average of the measurement results.

As shown in FIG. **4**, variations in unnecessary radiation from the samples of the magnetron **1** of the embodiment are smaller than variations in unnecessary radiation from the comparative sample examples. Moreover, the average of unnecessary radiation levels of the samples of the magnetron **1** of the embodiment is about 15.5 [dB] and smaller than the average (about 23 [dB]) of the unnecessary radiation levels of the comparative sample examples.

FIG. **5** shows results of measurement of reactive currents [mA] in the samples of the magnetron **1** of the embodiment and the comparative sample examples. In FIG. **5**, (outlined) circular symbols depict results of measurement of the samples of the magnetron **1** of the embodiment, and a horizontal bar depicts an average of the measurement results. Further, (outlined) triangular symbols in FIG. **5** depict results of measurement of reactive currents in the comparative sample examples, and an (outlined) horizontal bar depicts an average of the measurement results.

As shown in FIG. **5**, variations in reactive current in the respective samples of the magnetron **1** of the embodiment are smaller than variations in reactive current in the respective comparative sample examples. Moreover, the average of reactive currents in the samples of the magnetron **1** of the embodiment is about 5.0 [mA] and smaller than the average (about 5.9 [mA]) of the reactive currents in the comparative sample examples.

FIG. **6** shows results of measurement of oscillation efficiency [%] of the samples of the magnetron **1** of the embodiment and the comparative sample examples. In FIG. **6**, (outlined) circular symbols depict measurement results of the samples of the magnetron **1** of the embodiment, and a horizontal bar depicts an average of the measurement results. Further, (outlined) triangular symbols in FIG. **6** depict results of measurement of oscillation efficiency of the comparative sample examples, and an (outlined) horizontal bar depicts an average of the measurement results.

As shown in FIG. **6**, variations in oscillation efficiency of the respective samples of the magnetron **1** of the embodiment are smaller than variations in oscillation efficiency of the respective comparative sample examples. Moreover, the average of oscillation efficiency of the samples of the magnetron **1** of the embodiment is about 72.2 [%] and greater than the average (about 71 [%]) of oscillation efficiency of the comparative sample examples.

Next, FIG. **7** shows results of measurement of mounting heights of the respective anode vanes **19**A to **19**J, in connection with the sample of the magnetron **1** of the embodiment that has exhibited a measurement result of highest oscillation efficiency. A vertical axis of FIG. **7** represents mounting heights of the respective anode vanes **19**A to **19**J, whereas a horizontal axis of FIG. **7** represents the respective anode vanes **19**A to **19**J by means of reference numerals **19**A to **19**J.

As represented by FIG. **7**, mounting heights "h" of the respective anode vanes **19**A to **19**J of the sample of the magnetron **1** of the embodiment exhibited a measured result of the highest oscillation efficiency become lower stepwise from the anode vane **19**A closest to the bent portion **26**A of the center lead **26** to the anode vane **19**F situated opposite the anode vane **19**A on the inner peripheral surface of the anode cylinder **11**.

The fact is described by reference to FIG. **8**. FIG. **8** is a diagram showing appearance of the cathode filament **23** before and during operation of the magnetron **1** of the embodiment.

As shown in FIG. **8**, when the magnetron **1** operates, the cathode filament **23** and the upper end shield **24** both of which are supported by the center lead become inclined, for reasons of displacement attributable to thermal expansion of the bent portion **26**A of the center lead, from a position that is achieved before operation of the magnetron and that is indicated by a dotted line in the drawing, to a position achieved during operation of the magnetron. A component of a direction of inclination of the cathode filament **23** and the upper end shield **24** on a direction perpendicular to the axial direction of the anode cylinder **11** as indicated by an arrow in FIG. **8** coincides with the direction of the component (as indicated by the arrow shown in FIG. **1**) of the curved direction of the bent portion **26**A of the center lead **26** on the direction perpendicular to the axial direction. By reference to FIGS. **1** and **2**, the anode vane **19**F situated opposite the anode vane **19**A on the inner peripheral surface of the anode cylinder **11** is placed, with respect to the anode vane **19**A, at an imaginary extension of the direction of the component (as indicated by the arrow shown in FIG. **1**) of the curved direction of the bent portion **26**A of the center lead **26** on the direction perpendicular to the axial direction.

As mentioned above, in the magnetron **1** of the embodiment of the present invention, the component of a direction in which the cathode filament **23** becomes inclined on the direction perpendicular to the axial direction of the anode cylinder **11** coincides with the direction of the component (as indicated by the arrow shown in FIG. **1**) of the curved direction of the bent portion **26**A of the center lead **26** on the direction perpendicular to the axial direction. Therefore, when compared with the comparative example in which the plurality of anode vanes **19**A to **19**F are mounted at the same height, the magnetron **1** of the embodiment of the present invention exhibits high oscillation efficiency and can be operated at a small reactive current and with small unnecessary radiation.

As mentioned above, the magnetron **1** of the first embodiment has an anode cylinder on an inner peripheral surface of which a plurality of anode vanes are provided at a predetermined interval; a center lead including a first linear portion, a second linear portion that is parallel to the first linear portion and that is situated out of alignment with the first linear portion within a plane perpendicular to an axial direction of the anode cylinder, and a bent portion that connects the first linear portion to the second linear portion; and a cathode filament that is supported by the center lead within the anode cylinder and that is placed coaxially with the anode cylinder. The center lead is formed so as to become bent between the first linear portion and the second linear portion by means of the bent portion. The position of one anode vane closest to the bent portion is higher than the position of another anode vane with respect to the axial direction of the anode cylinder.

With this configuration, it is possible to suppress generation of a reactive current and noise, thereby enhancing oscillation efficiency.

In the magnetron **1** of the present embodiment, the plurality of anode vanes **19**A to **19**J are formed from the ten anode vanes **19**A to **19**J. The essential requirement for the anode vanes is that they be formed from an even number of anode vanes.

In the magnetron **1** of the present embodiment, even when the bent portion **26**A of the center lead **26** is situated between two anode vanes in the axial direction of the anode cylinder **11**, any one of the two anode vanes may be taken as one anode vane closest to the bent portion.

Although the embodiment of the present invention has been described, the present invention is not limited to the matter described in the embodiment. The present invention is also expected to be subjected to modifications and applications contrived by the artisans based on the descriptions of the present specification and the well known techniques, and the modifications and applications shall fall within a range where protection of the invention is sought.

The present invention is based on Japanese Patent Application (Application No. 2008-302771) filed on Nov. 27, 2008 in Japan, the entire contents of which are incorporated herein by reference.

INDUSTRIAL APPLICABILITY

The magnetron and the device using microwaves of the present invention provide an advantage of suppressing generation of a reactive current and noise thereby enhancing oscillation efficiency during operation of the magnetron, and are useful as a device using microwaves such as a microwave oven.

The invention claimed is:

1. A magnetron comprising:

an anode cylinder comprising a plurality of anode vanes disposed at a predetermined interval on an inner peripheral surface thereof;

a center lead comprising a first linear portion, a second linear portion which is disposed parallel to the first linear portion and which is disposed out of alignment with the first linear portion in a plane perpendicular to an axial direction of the anode cylinder, and a bent portion which connects the first linear portion to the second linear portion; and

a cathode filament which is supported by the center lead within the anode cylinder and which is placed coaxially with the anode cylinder,

wherein the center lead is formed so as to become bent between the first linear portion and the second linear portion by the bent portion, and

wherein a position of one anode vane closest to the bent portion is higher than a position of another anode vane with respect to the axial direction of the anode cylinder.

2. The magnetron according to claim **1**,

wherein an antenna lead is connected to the one anode vane.

3. A device using microwaves comprising the magnetron according to claim **1**.

4. A magnetron comprising:

an anode cylinder comprising a plurality of anode vanes disposed at a predetermined interval on an inner peripheral surface thereof;

a center lead comprising a first linear portion, a second linear portion which is disposed parallel to the first linear portion and which is disposed out of alignment with the first linear portion in a plane perpendicular to an axial direction of the anode cylinder, and a bent portion which connects the first linear portion to the second linear portion; and

a cathode filament which is supported by the center lead within the anode cylinder and which is placed coaxially with the anode cylinder,

wherein the center lead is formed so as to become bent between the first linear portion and the second linear portion by the bent portion,

wherein a position of one anode vane closest to the bent portion is higher than a position of another anode vane with respect to the axial direction of the anode cylinder, and

wherein positions of the plurality of anode vanes become lower stepwise in the axial direction of the cylindrical anode from the one anode vane to the another anode vane.

5. The magnetron according to claim **4**,

wherein when the magnetron operates, a component of a direction in which the cathode filament becomes inclined because of thermal expansion of the bent portion of the center lead on a direction perpendicular to the axial direction of the anode cylinder is identical with a component of a curved direction of the center lead on the direction perpendicular to the axial direction.

6. The magnetron according to claim **4**,

wherein an antenna lead is connected to the one anode vane.

7. A device using microwaves comprising the magnetron according to claim **4**.

8. A magnetron comprising:

an anode cylinder comprising a plurality of anode vanes disposed at a predetermined interval on an inner peripheral surface thereof;

a center lead comprising a first linear portion, a second linear portion which is disposed parallel to the first linear portion and which is disposed out of alignment with the first linear portion in a plane perpendicular to an axial direction of the anode cylinder, and a bent portion which connects the first linear portion to the second linear portion; and

a cathode filament which is supported by the center lead within the anode cylinder and which is placed coaxially with the anode cylinder,

wherein the center lead is formed so as to become bent between the first linear portion and the second linear portion by the bent portion,

wherein a position of one anode vane closest to the bent portion is higher than a position of another anode vane with respect to the axial direction of the anode cylinder, and

wherein when the magnetron operates, a component of a direction in which the cathode filament becomes inclined because of thermal expansion of the bent portion of the center lead on a direction perpendicular to the axial direction of the anode cylinder is identical with a component of a curved direction of the center lead on the direction perpendicular to the axial direction.

9. The magnetron according to claim **8**,

wherein positions of the plurality of anode vanes become lower stepwise in the axial direction of the cylindrical anode from the one anode vane to the another anode vane.

10. The magnetron according to claim **8**,

wherein an antenna lead is connected to the one anode vane.

11. A device using microwaves comprising the magnetron according to claim **8**.

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